REMARKS

The Examiner has objected to Applicant's amendment of the Specification, at pages 14-15 thereof, for introduction of new matter. Specifically, the Examiner has objected to introduction by Applicant of language referring to an "equivalent ratio". Accordingly, Applicant has amended the relevant paragraph to return to the original language.

The Examiner has rejected claim 51 as being indefinite, stating that it is not clear what polymer/resin is covered. The Examiner says that it is not clear whether the resin is made by reacting all of the listed monomers in a chloroethane solvent.

Applicant encloses herewith a copy of a printout of the Chemical Abstracts Service (CAS) Registry data for the chemical compound whose CAS Registry Number is 41618-91-1 (a similar printout was incorporated into Applicant's response to the Office Action of 01/15/2002 (Paper No. 20)). The printout discloses 8 alternative names for compound number 41618-91-1. The first name appearing on the printout is 2-propenoic acid, 2-hydroxypropyl ester, polymer with chloroethene and ethenyl acetate, the same compound name that appears in claim 51. Applicant submits that all 8 names are equivalent and acceptable means for identifying the compound.

As can be seen from the enclosed CAS printout, the compound is a copolymer, (the words "polymer with" in the chemical name "2-propenoic acid, 2-hydroxypropyl ester, polymer with chloroethene and ethenyl acetate" imply the formation of a copolymer) which is formed by reaction of three components or mers:

Component 1:

Me-CHOH-CH2-O-CO-CH=CH2

Component 2:

H2C=CH-Cl

Component 3:

AcO-CH=CH2

Applicant submits that the name used to refer to the reactive resin in claim 51, (2-propenoic acid, 2-hydroxypropyl ester, polymer with chloroethene and ethenyl acetate) is the index name used by the Chemical Abstracts Service. Applicant therefore submits that the name is not indefinite. Applicant further submits that it would be obvious to those skilled in the art that the components are not only mixed together, but also reacted to form the copolymer or reactive resin. However, out of an abundance of caution and in an effort to ensure that the present application is as clear and precise as possible, Applicant has amended claim 51 to read as follows:

51. The conduit of claim 47, wherein said reactive resin is a polymer, said polymer being a copolymer of 2-propenoic acid, 2-hydroxypropyl ester, ~~polymer with~~ chloroethene and ethenyl acetate.

Applicant submits that, in light of the above arguments and amendment, claim 51 is in condition of allowance.

The Examiner has rejected claims 47-49, 51-53 and 61 as being obvious in light of U.S. Pat. No. 4,792,493, issued to Bertram, (the '493 Patent) in view of U.S. Pat. No. 4,015,044, issued to Ranney (the '044 Patent).

The Examiner states that the '493 Patent discloses preparation of the PVC layer by flame or corona treatment and coating it with a polyurethane primer-activator. The Examiner goes on to state that the pretreatment of the PVC disclosed by the '493 Patent suggests its impregnation with a bonding agent.

Applicant submits that the '493 Patent does not discuss impregnation of the thermoplastic liner with a bonding or other agent. In contrast, the present application specifically discusses impregnation of the thermoplastic sheet with a reactive resin, as is demonstrated by the following passages:

> The face of the sheet facing the corroded substrate is impregnated with a reactive resin that will react with a curing agent for a cellular thermosetting resin. (see page 8, lines 9-11 of the present application)

> The thermoplastic material of sheet 28 is in the preferred embodiment a polyvinyl chloride. The sheet has two faces. A first face 70 faces the space 36 and interior surface 22 of the substrate 18. The second face 71 faces the interior of the substrate 18. The face 70 facing the space 36 is treated prior to installation within the conduit 14 by treating that surface with 2-propenoic acid, 2-hydroxypropyl ester, polymer with chloroethene and ethenyl acetate reactive resin having a density of 1.37 grams per cubic centimeter at 25 degrees Centigrade and a molecular weight of from 8,000 to 10,000. The reactive resin may contain a catalyst to enhance and cause a preference for a molecular linkage between the thermoplastic sheet 28 and the thermoset material 54. Such treatment impregnates the polyvinyl chloride sheet 28 through that surface 70, leaving hydroxyl ions along with the catalyst on the surface 70 available for bonding with the isocyanate or other bonding agent which is part of the curing agent for the thermosetting resin. (see page 14 lines 13-25 of the present application)

The present application also discusses preparation of the PVC layer by flame or corona treatment and application of a polyurethane primer-activator, (see page 17, lines 8-14 of the present application) thereby clearly implying that the impregnation steps discussed above are separate and distinct from the flame, corona, or primer activator pretreatment. Therefore, Applicant submits that the Examiner's assertion, that the pretreatment of the PVC disclosed by the '493 Patent includes impregnation with a bonding agent, is inconsistent with the specification of the present application.

The conclusion that the surface pretreatment and impregnation of the thermoplastic layer with a reactive resin are separate and distinct is further reinforced by the fact that the present application draws a direct link between the impregnation of the thermoplastic sheet with the reactive resin, the resulting molecular bonding and the improved structural properties of the rehabilitated conduit:

> When the thermoset 54 is filled within the space 36, the isocyanate will chemically bond with the available hydroxyl ions embedded to the sheet 28 to create an integrated, composite structure comprising a polyvinyl chloride region at one end, a region on the other end comprising the cellular thermoset material 54, and, in progressing across the cross-section from one to the other, an interphase region 74 where the polyvinyl chloride with its available hydroxyl ions have molecularly integrated with the isocyanate of the cellular thermoset 54. This bonding is universal and generally complete over the entire active treated area of the first face 70 of the polyvinyl chloride sheet 28, and the corresponding area of the thermosetting material 54 coming into contact with the face 70 after the thermosetting material cures and sets. (see page 15 lines 3-13 of the present application)
>
> The side or surface of the sheet section 30 which is to be positioned facing the interior surface 22 of the corroded concrete substrate 18 is treated and activated so as to form a chemical bond with materials included in a thermosetting material, such as, in the case of polyvinyl chloride, the impregnation of the surface with a substance that results in free hydroxyl ions that will bond

chemically with isocyanate in a thermoset curing agent for a thermosetting resin. (see page 17, lines 1-7)

The resulting structure, as depicted in the schematic cross-sectional cut-away view or slice in Fig. 9, is a chemically integrated and continuous, composite structure 110 having some five regions, each with differing physical characteristics contributing to a conduit much stronger, more resilient and longer lasting than the conduit, even as originally constructed. Significantly, the resultant structure 110 makes use of the entire pre-existing, corroded substrate 18 and whatever residual strength and physical characteristics the deteriorated substrate 18 possessed prior to restoration. (see page 21, lines 14-21 of the present application)

The cellular thermoset formed in the middle region of the structure of my invention provides resilient, flexible but tough strength to the resulting composite, integrated material and structure. Further, the bonding between the various regions is molecular, and is universal substantially throughout the interphases between the proximal regions, which has the advantage of transferring loads from the outside of the conduit throughout the resulting integrated material and structure. (see page 27, lines 3-9 of the present application)

Applicant submits that a central aspect of the present invention is that it results in a significant improvement in the structural strength of the deteriorated pipe or conduit (see, for example, page 7 lines 4-9 of the present application). In fact, the present invention often results in a rehabilitated pipe or conduit having greater structural strength than the pipe or conduit as originally

constructed. In contrast, the '493 Patent provides no such advantage. See, for example, the following passage, which may be found in U.S. Pat. No 5,389,692 (at col. 3, lines 21-36) and 5,268,392 (at col. 3, lines 8-24) both issued to Applicant and which have been incorporated into the present application by reference (see page 6, lines 24-26 of the present application):

> It has been known in the past to provide lining for the interior surfaces of such conduits and pipes. See, for example, my U.S. Pat. No. 4,792,493 issued to Vernie L. Belcher and myself. Such linings greatly enhance the ability of the conduit to resist the corrosive effects of the many acids, caustics, toxins and organic material common in waste water and sewer systems. Lining, however, is appropriate only where the fundamental integrity of the conduit wall is substantially unimpaired, and its thickness is sufficiently strong enough to contain the substances being conducted through the pipe or conduit and sufficiently strong enough to support the earth and roadway systems above it. Where the integrity of the conduit wall is diminished, restoration of the concrete or metal structure of the conduit is necessary before a lining is applied.

The surface treatment of the '493 patent involves roughening with a flame or corona discharge or by application of methylacetylene propane, (see '493 Patent col. 4, lines 32-50) which creates a micro-profile on the thermoplastic sheet, thereby enabling the thermosetting material to mechanically bond to the thermoplastic sheet. A clear moisture-cured polyurethane primer-activator is then applied to the thermoplastic sheet. The clear

moisture-cured polyurethane primer-activator described in the '493 patent forms a covalent bond with the urethane thermosetting material but not with the thermoplastic sheet itself. The bond between the thermoplastic sheet and the clear moisture-cured polyurethane primer-activator is an adhesive bond (i.e., weak forces such as hydrogen bonds, Van der Waals forces, polar-polar bonds, etc.). Applicant submits that the bond strength between the moisture-cured polyurethane primer-activator and the thermoplastic sheet of the '493 Patent is not sufficient to transmit and distribute significant amounts stress between the polyurethane and thermoplastic layers. Applicant therefore submits that the bond between the thermoplastic and polyurethane layers of the '493 Patent is inappropriate for structural composite sandwich construction.

As is discussed above, the thermoplastic sheet of the present invention can be treated by ionizing or roughening the surface, (see page 17, lines 8-14 of the present application) as can the thermoplastic sheets of the '493 and '392 Patents. However, the present invention additionally involves the impregnation of the thermoplastic sheet with a hydroxyl-bearing resin having reactive sites that can form covalent bonds with the urethane thermosetting material (see page 14, line 13 to page 15 line 13 of the present application). The bond between the hydroxyl-bearing resin and the thermoplastic sheet does not occur only at the surface of the sheet. Rather, the hydroxyl-bearing resin from the current application penetrates deep into the thermoplastic sheet by means of a

solvent solution that swells the thermoplastic sheet. The highly branched, high molecular weight molecules of the hydroxyl-bearing resin are trapped in the matrix of the thermoplastic sheet as the solvent solution evaporates. In addition, compatibility and chemical bonding that occurs between the hydroxyl-bearing resin and the thermoplastic sheet keeps the hydroxyl-bearing resin from diffusing out of the matrix of the thermoplastic sheet. The free hydroxyl groups impregnated inside the thermoplastic sheet are available to react with the free isocyanato groups from the urethane thermosetting material, which diffuses into the internal structure of the thermoplastic sheet. This results in an interphase region between the thermosetting material and the thermoplastic sheet, which is characterized by covalent bonds between the impregnated thermoplastic sheet and the urethane thermosetting material. In contrast, the interface between the thermoplastic sheet and thermoset of the '493 and '392 Patents consists of simple surface adhesive bonds.

The '493 Patent does not discuss the use of an excess concentration of isocyanato groups in the urethane thermosetting material relative to the concentration of hydroxyl groups in the thermoplastic sheet. In contrast, in the present invention it is imperative that the thermosetting material have an excess of isocyanato groups so that these can react with the hydroxyl groups that have been impregnated in the thermoplastic sheet. Referring to page 14, line 25 to page 15, line 2 of the present application, it is stated that:

> When the curing agent is mixed with the thermosetting resin in the gun 68, an adequate quantity of the isocyanate is calculated and included when conveying the mixture 54 in the delivery tube 62, for bonding with the hydroxyl ions resulting from the treatment of the surface 70 of the polyvinyl chloride sheet 28. Where the thermosetting resin is polyurethane resin or substantially polyurethane resin, and the curing agent is substantially isocyanates, it has been found that a volumetric ratio of isocyanate to resin of from 1.02:1 to 1.10:1 will provide the necessary quantity of the isocyanate.

The ratio of 1.02-1.10:1 indicates that an excess of isocyanate is required. It is desirable for the thermosetting material to have an excess of isocyanato groups so that the isocyanato groups can react not only with the hydroxyl groups at the surface of the thermoplastic sheet but also with the hydroxyl groups that have been impregnated in the thermoplastic sheet.

Whereas the '493 Patent discloses neither impregnation of the thermoplastic sheet with a reactive resin nor use of an excess of curing agent to react with the reactive resin, the present application makes it clear that there must be a sufficient amount of isocyanato groups of the curing agent to react with the hydroxyl groups of the reactive resin impregnated in the thermoplastic sheets (i.e. an excess of isocyanates):

> The face of the sheet facing the corroded substrate is impregnated with a reactive resin that will react with a

curing agent for a cellular thermosetting resin (see page 8, lines 9-11 of the application).

When the curing agent is mixed with the thermosetting resin in the gun 68, an adequate quantity of the isocyanate is calculated and included when conveying the mixture 54 in the delivery tube 62, for bonding with the hydroxyl ions resulting from the treatment for the surface 70 of the polyvinyl chloride sheet 28 (see page 14, lines 25-29 of the application).

The side or surface of the sheet section 30 which is to be positioned facing the interior surface 22 of the corroded concrete substrate 18 is treated and activated so as to form a chemical bond with materials included in a thermosetting material, such as, in the case of polyvinyl chloride, the impregnation of the surface with a substance that results in free hydroxyl ions that will bond chemically with isocyanate in a thermoset curing agent for a thermosetting resin (see page 17, lines 1-7 of the application).

When the thermoset 54 is filled within the space 36, the isocyanate will chemically bond with the available hydroxyl ions embedded to the sheet 28 to create an integrated, composite structure comprising a polyvinyl chloride region at one end, a region on the other end comprising the cellular thermoset material 54, and, in progressing across the cross-section from one to the other, an interphase region 74 where the polyvinyl chloride with its available hydroxyl ions have molecularly integrated with the isocyanate of the cellular thermoset 54 (see page 15, lines 3-9 of the application).

Notably, as seen progressing from the interior to the outside of the conduit, the initially encountered region

> within this composite, continuous chemically integrated structure is the polyvinyl chloride 28 having its second face 71 facing the interior of the conduit 14. This second face 71 has the ability to withstand chemical deterioration from the corrosive gases, acids and other elements. Continuously progressing toward the outer shell or reach of the conduit 14, the next region 74 comprises the chemically bonded hydroxyl ions with the isocyanates, which themselves are part of the thermoset material 54 (see page 21, lines 22-29 of the application).

Since the polyurethane layer of the '493 Patent does not contain an excess of isocyanate, and since the thermoplastic layer of the '493 Patent is not impregnated with a hydroxyl group bearing reactive resin, no covalent bonds are formed between the thermoplastic and polyurethane layers. Applicant submits that the covalent bonds formed between the thermoplastic and thermoset layers of the present invention are essential to the transfer of stresses between the layers, which results in a significant improvement in the structural strength of the rehabilitated pipe or conduit. Accordingly, the invention of the present application is not obvious in light of the '493 and '044 Patents.

In light of the above argument, Applicant submits that claim 47 of the present application adequately distinguishes the present invention from the prior art. With respect to the '493 Patent, claim 47 recites covalent bonds between the thermoplastic and thermoset layers and impregnation of the thermoplastic material with a reactive resin, neither of which are present in the '493 Patent.

Nevertheless, in order to make the distinction between the present invention and the prior art still clearer, claim 47 has been amended to recite "an excess of curing agent" in the thermosetting material. The '493 Patent does not discuss the use of an excess of curing agent.

The present invention is further distinguished from that of the '493 Patent by the fact that the reliability of the bond between the activated thermoplastic sheet and the urethane thermosetting material of the '493 Patent is affected by ambient moisture content and by application timing. In contrast, the hydroxyl-bearing resin of the present invention penetrates deep into the thermoplastic sheet forming a strong internal bond. The free hydroxyl groups impregnated inside the thermoplastic sheet are available to react with the free isocyanato groups from the urethane thermosetting material, which diffuses into the internal structure of the thermoplastic sheet. The hydroxyl groups impregnated in the thermoplastic sheet are not susceptible to reaction with ambient moisture, so ambient moisture content and application timing do not affect the quality of the bond. Therefore, the present invention provides a more reliable, stronger bond between the thermoplastic sheet and the thermosetting material.

At this point, Applicant wishes to make clear that the '392 and '692 Patents are also distinguishable from the present invention. The '692 Patent is directed to a co-polymer composition for coating a porous structure wherein the co-polymer composition is applied in one layer and has an

atmosphere-facing surface. The '692 Patent does not disclose a thermoplastic layer (see, for example, the Abstract and col. 3 line 40 to col. 4 line 30 of the '692 Patent).

The '392 Patent is directed to a rehabilitated conduit having a substratum of polyurethane foam and a relatively thin thermoplastic layer. The thermoplastic layer of the '392 Patent is treated by application of a clear moisture-cured primer-activator or discharge of electrical energy in the corona spectrum in a manner similar to that described in the '493 Patent. However, the '392 Patent does not disclose impregnation of the thermoplastic layer with a reactive resin. The bond formed between the polyurethane and thermoplastic layers of the '392 Patent is an adhesive bond, which is inadequate for the transfer of stresses between the layers. Furthermore, the '392 Patent requires a 1:1 ratio of resin to curing agent, which, as is discussed in detail above, does not provide a sufficient quantity of isocyanates to form covalent bonds between the thermoplastic and polyurethane layers. Finally, in contrast to the composite conduit of the present application, the rehabilitated structure of the '392 Patent remains flexible in order to resist cracking (see the '392 Patent at col. 2, line 64 to col. 3, line 6, and col. 3, lines 41-55).

In summary, the '493 Patent does not claim to improve the structural characteristics of the pipe or conduit. In light of the above discussion and the common knowledge of

those skilled in the art, Applicant submits that where the structural integrity of a pipe or conduit is compromised, the invention of the '493 Patent cannot be applied without first restoring the structure of the pipe or conduit. The improved structural characteristics of the present invention are directly linked to impregnation of the thermoplastic layer with a reactive resin and use of an excess of curing agent in the thermoset layer, neither of which is mentioned in the '493 and '044 Patents. Therefore, Applicant submits that the present invention is not obvious light of the Bertram (the '493 Patent) in view of Ranney (the '044 Patent).

In other words, the present invention is differentiated from the '493 Patent by the following elements and characteristics:

a) the thermoplastic layer of the present invention is impregnated with a reactive resin;
b) the thermoset layer of the present invention comprises an excess of isocyanate-bearing curing agent;
c) the thermoset and thermoplastic layers are bonded together by covalent bonds between the isocyanate groups and the reactive resin;
d) the strength of the bond between the thermoset and thermoplastic layers is strong enough to transmit and distribute stresses between the layers; and
e) the composite conduit of the present invention is significantly stronger than the original structure.

Applicant submits that independent claim 47 of the present application includes all of the above-recited elements, none of which are disclosed by the '493 and '044 Patents. Applicant therefore submits that the present invention, as defined by claim 47 of the application, is not rendered obvious by the '493 and '044 Patents.

In view of the foregoing amendments and remarks, favorable reconsideration of the Application is respectfully solicited.

Respectfully submitted,

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